Space Weather Technical Forecast

Issued on Thursday 26 December 2024 at 01:18 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Occasional R1/R2 radio blackouts expected throughout. A chance of G1/G2 geomagnetic storm intervals in next 24 hours.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has reduced somewhat but remains Moderate, with one double peak M-class flare observed, this measured at M4.9 and was observed with a contribution from AR3938 in the northeast and AR3932 near centre disk at 25/0444UTC.

There are now up to twelve sunspot regions on the disc, with one unnumbered region near the southeastern horizon, and a larger unipolar spot also in the southeast numbered AR3939. The most-changed regions on the disc included AR3938 in the northeast, which saw areal growth in its northern intermediate spots. AR3933 near centre-disc showed proliferation and then fading in its intermediate portions, which was matched at the same longitude by development and further fading in trailing spots in AR3928 to its immediate south. AR3932 in the southeast showed areal decay throughout - especially in its leading group - although the eastern penumbra does perhaps also still contain a weak Mt Wilson delta. All the unipolar groups were unchanged on the disc, aside from AR3934 in the northeast, which consolidated and faded in the period.

A Type II radio emission with an estimated speed of 1064km/s was observed at 25/0447UTC. This was almost concurrent with the peak flare of the period from AR3932, however recent coronagraph imagery instead suggests a large and fast CME is not expected, with a slower feature visible, largely southward directed although we await full model analysis of this feature to fully assess any Earth-directed competent.

Further CMEs observed in available coronagraph imagery are judged not to have a Earth-directed threat, although analysis continues into a CME visible moving northeast in coronagraph imagery from 25/1730UTC onwards.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE, showed a waning connection to CH01/-. The solar wind speed fell from Elevated levels around 550km/s to reach Slightly Elevated levels around 420km/s by the period's end. The solar wind density showed normal background single figures ppcc, which is perhaps the resumption of the ambient wind density. The IMF was at weak and slowly dropping levels, with a peak near 6nT. Bz initially erratic with the north-south component oscillating between the confines of +/-5nT, but with oscillation reducing through the period. The phi angle was negative (towards the Sun) throughout.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) showed a continuing gradual decline, with the current 24-hour period seeing an early 'peak' near 2pfu, well below the S1/Minor Radiation Storm threshold.

High energy electron flux (greater than 2MeV) observed by GOES16 was at generally Moderate levels, with the past 24 hours seeing a peak at 25/1505UTC near 770pfu. The associated 24-hour fluence was below the Active (1e8 integrated flux) threshold on a flat trend. The 26/0001UTC observation was 2.92e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are Expected, with a Slight Chance of isolated X-class flares throughout.

Solar Wind / Geomagnetic Activity: A CME from 23 December may give a glancing blow at Earth on Day 1 (26 Dec), with some uncertainty in the timing of this feature. No other CMEs currently feature in the forecast, although confidence in this aspect of the forecast is lower than usual. Solar winds are slightly elevated but slowly declining due to a waning connection to CH01/-.

Overall, geomagnetic activity is expected to be mainly Quiet to Unsettled during the forecast period, but with a Chance of peak G1-G2/Minor-Moderate Storm levels Day 1 (26 Dec) due to potential CME influence, with lower than usual confidence given the forecast uncertainties.

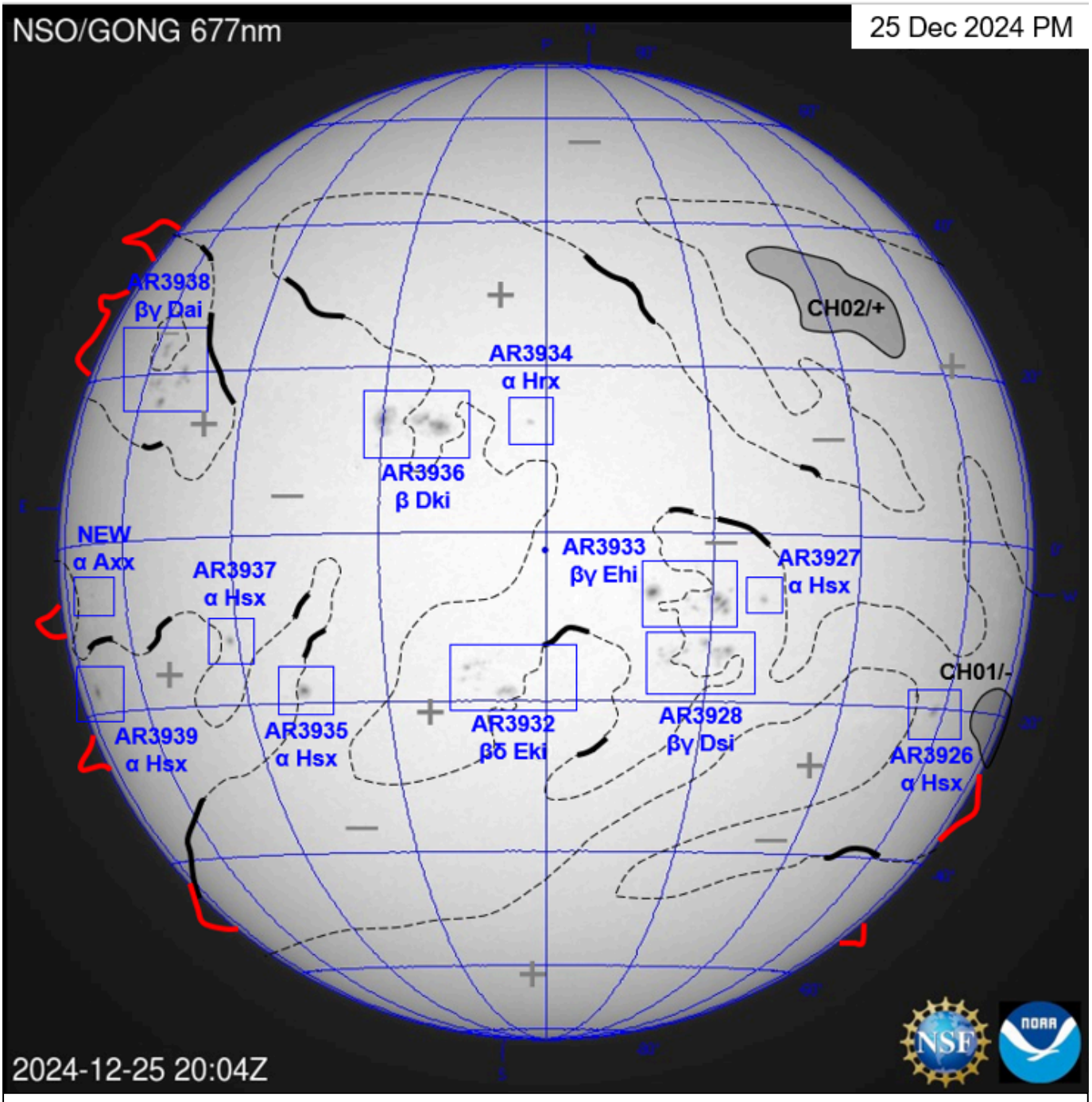
Energetic Particles / Solar Radiation: There is a Slight Chance of S1/Minor Radiation Storm or greater enhancements during the period. In the absence of any further notable flares, ongoing slightly enhanced high-energy proton counts should ease towards Background levels in the coming days.

The high energy electron forecast carries lower than average confidence due to the uncertainty in potential CME impacts. However, there is a Slight Chance of exceeding Active levels on Day 1 (26 Dec) should we fail to see any significant CME arrival. Thereafter a slowly increasing Chance through the period, but with low confidence.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1: Solar Synoptic Map valid 25/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms

There are two threads to the current geomagnetic forecast - the first and likely more significant a CME generated by the M8.9 flare from AR3923 and a nearby, sympathetic filament lift-off in the southeast disc. The bulk of the ejecta is modelled to pass below the Earth-Sun line, however a glancing blow remains possible early on Day 1 (26 Dec). ACE EPAM LEMS has shown a slight rise in the past 24 hours, although the rate has slowed which perhaps implies a more significant arrival is increasingly unlikely. Uncertainty in the timing of this feature is increased by ENLIL modelling suggesting a High Speed Stream (HSS) onset at a similar time, although no significant source coronal hole is visible in GOES SUVI 195 imagery. No other Earth-directed CMEs currently feature in the forecast, however due to the number of recent CMEs in solar imagery, confidence in this aspect of the forecast is lower than usual.

The second part of the forecast concerns coronal holes. Solar winds are elevated but slowly declining due to a waning connection to CH01/-. A further enhancement is possible, but unlikely on Days 1 and 2 (26 and 27 December) from CH02/+ located in the northwest disc. However, as discussed above, there is also the possibility of further enhancement from an uncertain source as modelled by ENLIL, but this viewed as very low confidence with solar winds expected to generally trend towards background later in the period in the absence of CME enhancement.

Overall, geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a Chance of peak G1-G2/Minor-Moderate Storm levels Day 1 (26 Dec) due to potential CME influence, with lower than usual confidence given the forecast uncertainties.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	10	5	5
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

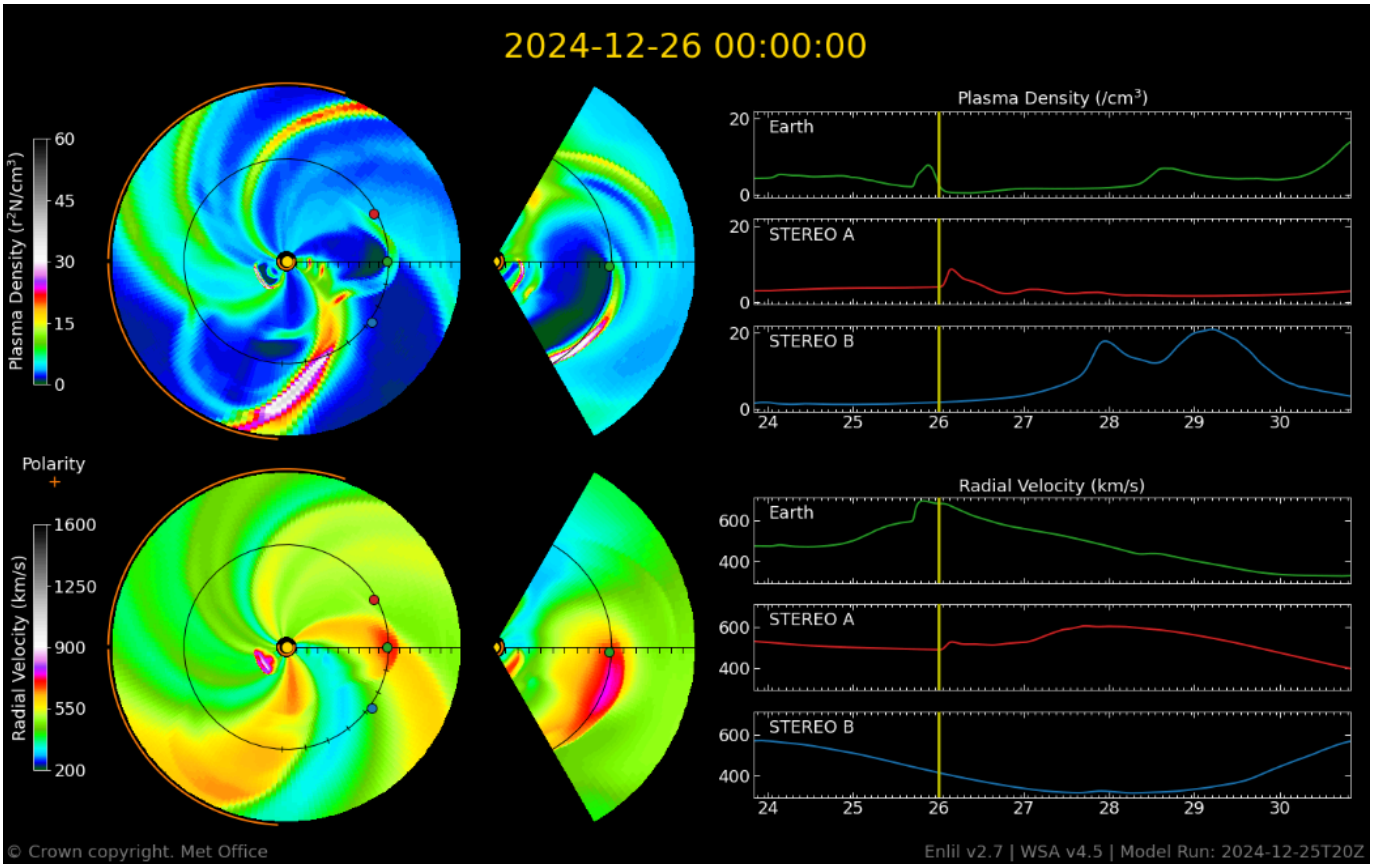
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
23/1550 UTC	Partial	Flare and Filament	SE disc (AR3932)	780	25/1800 UTC	Possible glancing blow, low confidence on timings. +/- 12 hours from Estimated Arrival Time.

Figure 2: Latest MOSWOC ENLIL output.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares

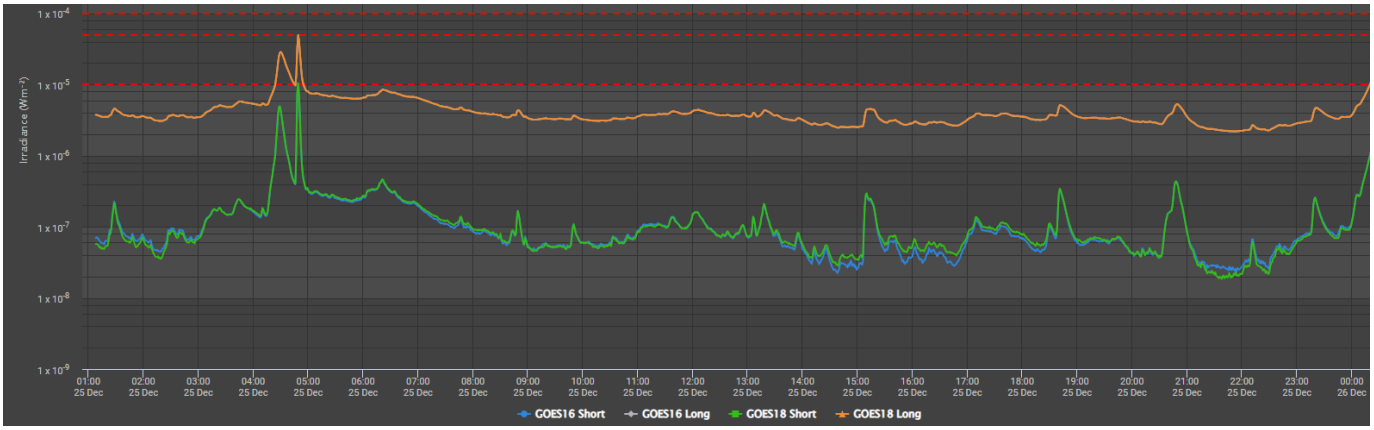
The Penticton 10.7cm flux is currently on a strong rising trend, reaching a peak for the rotation and rivalling the peak last seen at Hallowe'en. Many of the more complex regions on the disc are exhibiting growth and occupy positions near the middle of the disc, making them potential flare threats for many days yet.

Recurrence suggests the potential for further sunspot regions to round the eastern limb later in the period, with this supported by recent far-side CME activity although far-side sounding output is less confidant. No significant sunspot regions leave the disc in the four days.

The assessment of any new regions notwithstanding, flare risk looks to remain elevated during the period and further M-class flares are Expected, with a Slight Chance of X-class flares maintained throughout, pending further developments.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	15	15	15	15

Figure 3: Latest 24hr GOES16/18 X-Ray trace.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

High energy proton counts are slowly declining and should continue to ease towards typical Background values in the coming days in the absence of significant flaring. There remains an unaltered Slight Chance of S1/Minor Solar Radiation storms or greater, should any significant flares occur as the larger regions on the Earth-facing disc move into more favourable western locations for connection with Earth.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

High Energy Electrons (≥ 2MeV)

Current high energy electron flux has been at moderate levels in the last 24 hours. As solar wind pressure from CH01/- continues to ease, diurnally high electron flux levels are possible into the period. However, the likely arrival of a CME early Day 1 (26 December) may temporarily suppress electron counts at GEO, before potentially increasing again later in the period, dependent on intervening geomagnetic activity.

Electron fluence has been slowly declining over the last 24 hours, and is most likely to remain below the Active threshold for much of the period. However, there is a Slight Chance of exceeding Active levels on Day 1 (26 Dec) should we fail to see any significant CME arrival. Thereafter a slowly increasing Chance through the period, but with low confidence.

MOSWOC REFM is not likely to completely capture forecast conditions in the period given recent fast solar winds and the threat of CME influence that is not captured by the model.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	20	20	25	30
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.